FS SONNE Cruise 170

GENERAL DOCUMENTATION ABOUT THE CRUISE

INSTITUTION RESPONSIBLE FOR COLLECTING DATA:
NAME: **Institut für Meereskunde an der Universität Kiel**
COUNTRY: **Germany**

SHIP FROM WHICH DATA WERE COLLECTED:
SHIP NAME: **FS SONNE**
SHIP TYPE: **Research Vessel**
SHIP CALL SIGN: **DFCG**
LENGTH OF SHIP: **97.61 m**

CRUISE IDENTIFIERES:
PROJECT: **SO170 - Tropenzirkulation (03 G0170 A)**
CRUISE (LEG): **SO170**

CHIEF SCIENTIST: **Prof. Dr. Friedrich Schott**
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START DATE: **23/04/03**
END DATE: **22/05/03**

PORPOSE OF CRUISE AND BRIEF NARRATIVE:

"FS Sonne" cruise SO 170 consisted of two legs, of which the first one, SO 170/1, was the transit leg from Auckland (New Zealand) to Port of Spain (Trinidad and Tobago). Cruise SO 170/2 was devoted to physical oceanography studies in the tropical Atlantic, departing on 23 April 2003 from Port-of-Spain and ending on 22 May in Recife (Brazil).

1. Objectives addressed during the cruise:

Cruise SO 170/2 was carried out as part of the German Ocean/CLIVAR-program "Mechanisms of tropical-subtropical interactions". The main part of that project is an observational program with moorings, ship measurements and profiling floats to investigate the tropical-subtropical coupling of the warm water circulation in the western tropical South Atlantic. Key scientific goals of the program are:

- The pathways and transports of the shallow tropical-subtropical thermohaline cell (called "Subtropical Cell", STC) in the South Atlantic which connects the zonal equatorial circulation with the equatorward boundary currents off Brazil.
- The transport variations within this circulation cell on time scales of up to several years as well as the spreading of water mass anomalies between the subtropics and the tropics.
- The influence of STC variability on ocean- atmosphere interaction, especially in the

equatorial upwelling region (cooperation with the international PIRATA project).

- Transformation of water masses of the overall thermohaline circulation in the equatorial region.
- Study of ENSO - influences on the interhemispheric exchange.

There are two central objectives to "Sonne" cruise SO 170/2:

1. To retrieve the CLIVAR array of three stations off the coast of Brazil near 11^0S and redeploy four moored stations. The array has been in the water since March 2000 to measure the equator ward warm water transport with the North Brazil Undercurrent and the associated variability. At the same time, the southward flow of North Atlantic Deep Water (NADW) can be recorded with instruments deployed within the deep part of the moored stations.
2. To carry out shipboard current profiling with shipboard ADCP and lowered ADCP (LADCP) as well as CTD hydrography along sections crucial to the above described studies of tropical-subtropical interactions. For SO 170/2 the specific objectives of the shipboard observational program were:
    - To measure the circulation in the western tropical Atlantic between Trinidad and the eastern tip of Brazil along two zonal and two meridional sections across the Guyana Basin, running about parallel and normal to the coast :
      --the first one a zonal section along about 10^0N, eastward to 53^0W
      --from there southward to the coast of French Guyana,
      --then eastward again along 7.5^0N to 40^0W
      --and finally southward along 40^0W
      These sections enclose boxes for which it will be attempted to determine water mass budgets for the individual layers and determine the pathways of circulation branches. The particular interest here is to determine the fate of the waters that are carried across the equator at the western boundary by the North Brazil Current (NBC).
    - To repeat the CLIVAR sections along 5^0S and 11.5^0S and connect them at the eastern end by a meridional section along 28.5^0W. Here we determine the changes in transports of the STC and of its water mass properties. The particular interest for the zonal sections into the interior is to find out how much of the equatorward warm water transport is occurring in the interior, compared to the proximity of the western boundary where our CLIVAR array is located.

In both regions the sections serve at firming up our knowledge about the deep circulation and find out more about the processes that cause a transformation of colder NADW waters into somewhat warmer water classes somewhere in the equatorial zone.

2. Narrative

The scientific contingent of cruise SO 170/2 arrived in Port of Spain in the evening of Easter Monday, 21 April. "Sonne" departed from Port of Spain, Trinidad, at 8 am on 23 April and proceeded around the north-western part of the island towards the beginning of the first oceanographic section along 10^0 15'N. During this short transit time the equipment installation and start-up continued and was just completed when the ship arrived at the

western end point of the 10^0 15'N line, at 60^0 30'W, where the ADCP measurements began in the afternoon of 23 April.
At the shelf edge, the work with CTD and lowered ADCP (LADCP) was started. The station separation was increased when the deep part of the continental slope was reached. The eastward course was terminated at 52^0 45'W in the evening of 26 April, and a section toward the boundary of French Guyana was begun.
The southward course encountered the steep topography of the Demerara Plateau near 8^0 45'N, and station distance was reduced accordingly. The southernmost station (25) of that southward section at 500m water depth was reached in the afternoon of 28 April, at 7^0 20'N. After termination of the CTD stations the course was continued up the slope to the 200m line at 7^0 03'N so that no significant shallow transport might be missed at the shoreward end.
Then "Sonne" headed eastward along 7.5^0 N, with widely spaced shallow CTD/LADCP stations toward the 40W section. Along the way, tests were carried out to determine the measurement range of the new "Longranger" ADCP that is planned for use in upper-layer measurements in the moorings near 11^0S.
On 1 May at noon, the meridional section toward the coast was commenced, with stations to the bottom again, first at 60 nm distance, then reduced to about half that around the Ceara Rise and again the equatorial zone. Strong currents were encountered south of 1°N, stemming from the retroflection of the North Brazil Current into the Equatorial Undercurrent. The section was terminated in the evening of 5 May, and the 2.5 day transit toward the moored stations at 11^0S began along the coast, at first heading into the strong NBC which slowed the ship down to near 10 kn.
The next segment of the cruise was devoted to exchange of the moored stations at 10-11^0 S, beginning with the retrieval of station K3_2 in the morning of 8 May. The next two moorings were retrieved in the afternoon of 8 May (K2_3) and early on 9 May (K4_3). In between retrievals and during preparations of deployments, CTD/LADCP profiles were collected along the mooring line at night time. The deployments of the four stations began early on 10 May, with K1_3 and K2_4, and was accomplished on 11 May with K3_3 and K4_4.
After completion of the deployments, "Sonne" proceeded eastward, repeating the section along 11^0 30'S toward 28.5^0W that was carried out in 2002 with "Meteor" (M53/2) to 28.5^0W. That point was reached in the evening of 14 May and the course changed to northward for a 28.5^0W section with alternating shallow and deep stations. It was decided to carry this section northward to about $2^0$40'S. In the afternoon of 17 May, the position $3^0$15'S was reached and the RAFOS sound source mooring deployed smoothly in a water depth of 5100m. Subsequently the course was continued to $2^0$40'S with CTD stations. On the way back southward, an additional station was taken at $3^0$36'S, and from there a short transit was begun to the starting point of the last SO 170/2 section, at 5^0S, $29^0$30'W.
Work at the 5^0S section was started in the afternoon of 18 May, first with larger station separations, reducing to 20 nm between 32^0 and 34^0W, then even less when approaching the continental slope. There were some topographic disturbances along that 5^0S section and we used the availability of the SIMRAD mapping technology to chart them on this cruise. The work ended at the western end of the slanted 5°S section, at 5°38'S, 34°57'W in the afternoon of 21 May and "Sonne" went on the short transit to Recife, to arrive there in the morning hours of 22 May. Cruise SO 170/2 had accomplished all its objectives